

(19)



Europäisches Patentamt  
European Patent Office  
Office européen des brevets



(11) Publication number:

**0 560 290 A1**

(12)

## EUROPEAN PATENT APPLICATION

(21) Application number: 93103771.7

(51) Int. Cl.<sup>5</sup>: F01N 3/28

(22) Date of filing: 09.03.93

(30) Priority: 09.03.92 JP 50408/92  
09.03.92 JP 50409/92  
09.03.92 JP 50413/92  
09.03.92 JP 50414/92

(43) Date of publication of application:  
15.09.93 Bulletin 93/37

(94) Designated Contracting States:  
DE FR GB NL

(71) Applicant: MITSUBISHI JIDOSHA KOGYO  
KABUSHIKI KAISHA  
33-8, Shiba 5-chome Minato-ku  
Tokyo 108(JP)  
Applicant: MITSUBISHI JIDOSHA  
ENGINEERING KABUSHIKI KAISHA  
21-1, Shlmomaruko, 4-chome, Ohta-ku  
Tokyo(JP)

(72) Inventor: Danno, Yoshiaki  
2-1-2-502, Oharano Nishisakaidanicho  
Nishikyo-ku, Kyoto-shi, Kyoto(JP)  
Inventor: Koga, Kazuo  
58-53, Oyamazakicho Enmyoji Matsuda  
Otokuni-gun, Kyoto(JP)  
Inventor: Tanida, Tetsuya  
7-17, Higashino Butaimachi, Yamashina-ku  
Kyoto-shi, Kyoto(JP)  
Inventor: Ishida, Hidekazu, 237 Kyotoshijo  
Gurandohaitsu  
6, Yamanouchi Ikejiricho, Ukyo-ku  
Kyoto-shi, Kyoto(JP)

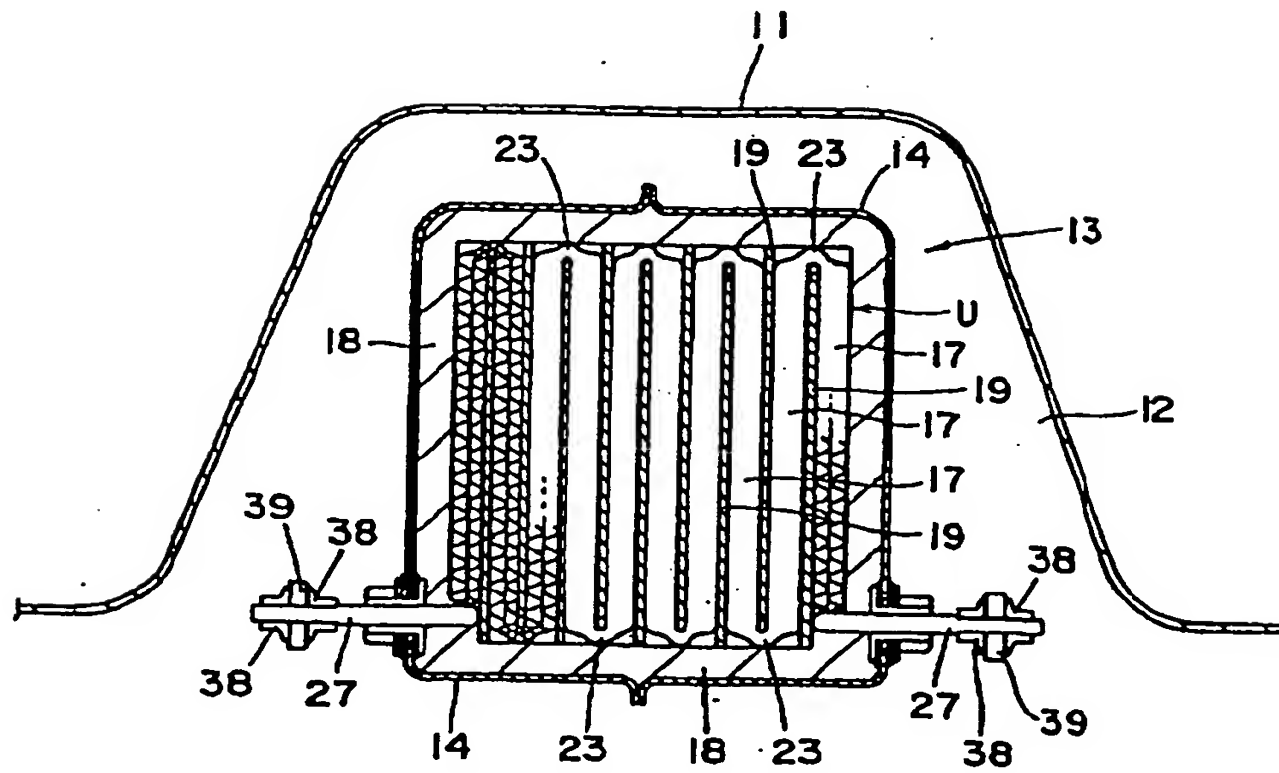
(74) Representative: Strehl Schübel-Hopf Groening  
& Partner  
Maximilianstrasse 54  
D-80538 München (DE)

(54) Exhaust gas purifying catalytic converter and its fabrication method.

(57) Disclosed is an exhaust gas purifying catalytic converter (13) comprising: a plurality of catalyst units (17) arranged to be spaced in parallel to each other in the direction crossing to the flow direction of the exhaust gas of an internal combustion engine; unit connecting means (23) for electrically connecting one-end sides of the catalyst units to the other end sides thereof in the direction crossing to the array direction of the catalyst units (17) and to the flow direction of the exhaust gas so as to be alternate along the array direction; a casing (14) for surrounding a plurality of the catalyst units (17) through insulating support layers (18); and a pair of electrodes (27) which are electrically connected to two catalyst units positioned at both ends in the array direction, and which pass through the insulating sup-

port layer (18) and the casing to be introduced outside the casing and to be connected to a power supply. Further, the exhaust gas purifying catalytic converter is fabricated according to the steps of: crushing a catalyst carrier having a strip-like honeycomb structure, in which a plurality of reaction passages are formed in parallel to each other, for each interval in the direction parallel to the reaction passages; and folding the crushed portions alternately in the reversed direction at approximately 180°, thereby arranging the catalyst carrier in a zigzag manner. With this construction, it is possible to provide an exhaust gas purifying catalytic converter (13) capable of effectively activating the catalyst for a short time.

FIG.2



The present invention relates to an exhaust gas purifying catalytic converter of previously electrically heating a catalyst in cold-starting of an internal combustion engine for enhancing the activation of the catalyst, and its fabrication method.

In the combustion gas discharged from an internal combustion engine using fossil fuel such as gasoline and gas oil (hereinafter, referred to as exhaust gas), there is often contained harmful materials such as hydrocarbon and nitrogen oxide. Various problems may be encountered in releasing such exhaust gas in the atmospheric air as it is.

To cope with the above problem, as is well known, there have been developed and put in practical use an exhaust gas purifying apparatus using the three way catalyst for making the above harmful materials harmless by enhancing the purification due to combustion of hydrocarbon, or reduction of nitrogen oxide. Namely, the catalytic converter in which the three way catalyst is carried is built in the midway of an exhaust gas passage of the internal combustion engine, so that the above harmful materials are made to be harmless during they pass through the catalytic converter, to be thus released in the atmospheric air.

However, the prior art three way catalyst of the catalytic converter becomes extremely different in the catalytic ability of enhancing the oxidation-reduction reaction of the harmful material depending on the temperature, and consequently cannot sufficiently enhance the purification of the hydrocarbon in the inactivated state after cold-starting of the engine.

Thus, there has been developed an exhaust gas purifying apparatus having the following construction: namely, an auxiliary catalytic converter, in which an oxidation catalyst is carried, is built in the midway of the exhaust gas passage on the upstream side from the catalytic converter in which the three way catalyst is carried (hereinafter, referred to as main catalytic converter). With this construction, when the three way catalyst of the main catalytic converter is inactivated, the auxiliary catalytic converter is electrically heated to activate the oxidation catalyst, thereby enhancing the purification of the hydrocarbon.

The concept of an exhaust gas purifying apparatus in which the above auxiliary catalytic converter is built is shown in Fig. 22. In this figure, an auxiliary catalytic converter 3 carrying an oxidation catalyst is provided in the midway of an exhaust gas passage 2 on the upstream side from a main catalytic converter 1 carrying a three way catalyst. The auxiliary catalytic converter 3 is connected to a power supply 5 through a catalyst switch 4 interlocked with an ignition key switch (not shown). Namely, upon cold-starting of an engine 6, the catalyst switch 4 is turned on, and the auxiliary catalytic

converter 3 is applied with a current from the power supply 5. Thus, the oxidation catalyst of the auxiliary catalytic converter 3 is heated up to an activation temperature, after which the engine 6 is started and the auxiliary catalytic converter 3 purifies hydrocarbon contained in the exhaust gas flowing in the exhaust gas passage 2. Then, when the three way catalyst of the main catalytic converter 1 reaches an activation temperature, the catalytic switch 4 is turned-off, to thereby stop the current-carrying to the auxiliary catalytic converter 3.

Accordingly, as the carrier for carrying the oxidation catalyst of the auxiliary catalytic converter 3 is electrically heated by the power supply, a metal system including a heat resisting alloy such as an iron-chromium-aluminum system is mainly adopted.

In the exhaust gas purifying apparatus using the oxidation catalyst and three way catalyst as shown in Fig. 22, it is required to heat the auxiliary catalytic converter 3 carrying the oxidation catalyst in cold-starting the engine 6. With this regard, conventionally, there has been adopted a heating type using the heat generation caused by the electric resistance of the carrier for carrying the oxidation catalyst.

For activation of the oxidation catalyst of the auxiliary catalytic converter 3 for a short time, there are considered various techniques of: decreasing the electric resistance of the carrier for carrying the oxidation catalyst; increasing the supply voltage to the auxiliary catalytic converter 3; and increasing the supply voltage to the auxiliary catalytic converter 3 while increasing the electric resistance of the carrier for carrying the oxidation catalyst.

However, in the technique of decreasing the electric resistance of the carrier for carrying the oxidation catalyst, or of increasing the supply voltage to the auxiliary catalytic converter 3, the auxiliary catalytic converter 3 is supplied with a large current, which requires the power supply 5 to have a remarkably large capacity.

On the contrary, in the technique of increasing the supply voltage to the auxiliary catalytic converter 3 while increasing the electric resistance of the carrier for carrying the oxidation catalyst, it is possible to effectively activate the oxidation catalyst for a short time without changing the capacity of the power supply 5 too much. However, since the prior art heat resisting alloy of an iron-chromium-aluminum system constituting the carrier does not leave a high electric resistance, the absolute amount of generated heat is small, so that it is inevitably required to use a power supply 5 having a remarkably large capacity, or to modify the structure of the supporter itself for increasing the length of the carrier along the current-carrying direction (hereinafter, referred to as current pas-

sage length). To satisfy the above requirement, there is the disadvantage of enlarging the size of the auxiliary catalytic converter 3.

In addition, there it may be considered to use a metal material having a high electric resistance as a carrier; however, such a new material to be used in place of the existing material has not yet been found in terms of the material cost, workability and the like, and accordingly, it is unavoidable to use the existing material.

Taking the above circumstances into consideration, it is object of the present invention to provide a compact catalytic converter for purifying exhaust gas capable of effectively activating an oxidation catalyst for a short time without increasing the capacity of the power supply or replacing the prior art carrier material, and its fabrication method.

An exhaust gas purifying catalytic converter according to a first aspect of the invention comprises: a plurality of catalyst units arranged to be spaced in parallel to each other in the direction crossing to the flow direction of the exhaust gas of an internal combustion engine; unit connecting means for electrically connecting one-end sides of the catalyst units to the other end sides thereof in the direction crossing to the array direction of the catalyst units and to the flow direction of the exhaust gas so as to be alternate along the array direction; a casing for surrounding a plurality of the catalyst units; and a pair of electrodes which are electrically connected to two catalyst units positioned at both ends in the array direction, and which pass through the insulating support layer and the casing to be introduced outside the casing and to be connected to a power supply.

According to the invention, the current applied from the Power supply to the catalytic converter through the electrodes is allowed to flow in a zigzag manner between the catalyst unit on one end side along the array direction of the catalyst units and the catalyst unit on the other end side through the unit connecting means. Thus, the catalyst units are heated by means of the electric resistance of the carrier constituting the catalyst units during the current-carrying.

Also, since a plurality of the catalyst units are disposed in the multi-layer manner within the casing, the current passage length can be made longer without enlarging the size of the casing, thereby making it possible to increase the electric resistance of the carrier with a compact structure. Further, by increasing the supply voltage, it is possible to heat the catalyst for a short time without enlarging the capacity of the power supply, and hence to activate the catalyst for a short time.

Also, preferably, a plurality of catalyst unit groups, each being constituted of a plurality of the catalyst units, are arranged along the flow direction

of the exhaust gas, and one electrode of one catalyst unit group is connected in series to one electrode of the adjacent catalyst unit group.

With this construction, since the current passage length is increased in proportion to the number of the catalytic unit groups, it is possible to activate the catalyst for a further short time.

Preferably, each spacer having an electric insulating property is interposed in the gap between the catalyst units.

With this construction, since the spacer having an electric insulating property is interposed between the adjacent catalyst units, it is possible to prevent each catalyst unit from being electrically shortened by vibration or the like, and hence to make compact the catalytic converter without any problem.

Further, preferably, the casing is formed in a circular or polygonal shape in section, and the catalyst units are tightly arranged in the casing in the laminated state.

With this construction, it is possible to almost uniformly hold the whole of the catalyst units against the surroundings, and hence to prevent each catalyst unit from being damaged by the application of an uneven load, and further to avoid the enlargement of the size of the catalytic converter.

A method of fabricating an exhaust gas purifying catalytic converter according to a second aspect of the present invention comprises the steps of: crushing a catalyst carrier having a strip-like honeycomb structure, in which a plurality of reaction passages are formed in parallel to each other, for each interval in the direction parallel to the reaction passages; and folding the crushed portions alternately in the reversed direction at approximately  $180^\circ$ , thereby arranging the catalyst carrier in the zigzag manner.

With this method, it is possible to fabricate the catalyst units only by pressing and folding without adoption of the welding or the like, and hence to avoid the enlargement of the size of the catalytic converter and to reduce the production coat.

Further, preferably, the above method further comprises the steps of: crushing both surfaces of the catalyst carrier; contacting a core bar with any one of the crushed surfaces; folding the catalyst carrier along the core bar with respect to the core bar at  $180^\circ$ , thereby forming the folded portion.

With this method, since the folded portion is in the state being wound around the core bar at  $180^\circ$  or more, it is possible to enhance the mechanical strength of the folded portion.

The above and other features and advantages of the present invention will be apparent from the following detailed description of the preferred embodiments of the invention in conjunction with the

accompanying drawings, in which:

Fig. 1 is a schematic view showing a structure in which an exhaust gas purifying catalytic converter of the present invention is applied to a prior art exhaust gas purifying apparatus as shown in Fig. 22;

Fig. 2 is a sectional view taken along the line II-II of Fig. 1;

Fig. 3 is an enlarged sectional view of an electrode portion;

Fig. 4 is a view showing the whole construction in which the exhaust gas purifying catalytic converter of the present invention is applied to the exhaust gas purifying apparatus;

Fig. 5 is a time chart showing the series/parallel switching of batteries, switching of a catalyst switch, and ON/OFF switching of an ignition key;

Fig. 6 is a characteristic view of a current-carrying time;

Fig. 7 is a flow diagram showing a fabrication procedure for a catalyst unit folded portion along with Figs. 8 and 9;

Fig. 8 is a flow diagram showing the fabrication procedure for the catalyst unit folded portion along with Figs. 7 and 9;

Fig. 9 is a flow diagram showing the fabrication procedure for the catalyst unit folded portion along with Figs. 7 and 8;

Fig. 10 is a flow diagram showing another fabrication procedure for a catalyst unit folded portion along with Figs. 11 and 12;

Fig. 11 is a flow diagram showing another fabrication procedure for the catalyst unit folded portion along with Figs. 10 and 12;

Fig. 12 is a flow diagram showing another fabrication procedure for the catalyst unit folded portion along with Figs. 10 and 11;

Fig. 13 is a perspective view showing a structure of a second embodiment of the present invention;

Fig. 14 is a perspective view showing an appearance of a third embodiment of the present invention;

Fig. 15 is a perspective view showing a structure of the third embodiment of the present invention;

Fig. 16 is a sectional view showing a fourth embodiment of the present invention;

Fig. 17 is an enlarged sectional view of an electrode portion according to the fourth embodiment of the present invention;

Fig. 18 is another sectional view of the fourth embodiment of the present invention;

Fig. 19 is a flow diagram showing a fabrication procedure of a catalyst unit folded portion according to a fifth embodiment of the present invention along with Figs. 20 and 21;

Fig. 20 is a flow diagram showing a fabrication procedure of the catalyst unit folded portion according to the fifth embodiment of the present invention along with Figs. 19 and 21;

Fig. 21 is a flow diagram showing a fabrication procedure of the catalyst unit folded portion according to the fifth embodiment of the present invention along with Figs. 19 and 20; and

Fig. 22 is a schematic view showing a prior art exhaust gas purifying apparatus.

Hereinafter, the preferred embodiments of the present invention will be described in detail with reference to the accompanying drawings.

### Embodiment 1

With reference to Figs. 1 to 6, there will be described a first embodiment.

Fig. 1 shows the appearance of one embodiment of the invention in which an exhaust gas purifying catalytic converter of the present invention is applied to a prior art exhaust gas purifying apparatus as shown in Fig. 22; Fig. 2 shows the sectional structure taken along the line II-II of Fig. 1; and Fig. 3 shows an enlarged sectional structure of an electrode portion of the catalytic converter. As shown in these figures, an auxiliary catalytic converter 13 is stored in a floor tunnel 12 formed at the central portion of a floor panel 11 constituting a part of a vehicular body. It has a casing 14 having a right and left two-split structure in which two-pieces are finally seam-welded. At both ends of the casing 14, there are formed a connection flange 15 connected to an outlet side of an exhaust manifold 8 communicated to a combustion chamber 7 of an engine 6 as shown in Fig. 22, and a connection flange 16 connected to an outlet side of an exhaust tube 9 in which a main catalytic converter 1 carrying a three way catalyst is interposed on the mid-way.

In the casing 14 made of SUS 410 or the like, there are stored a catalyst unit group U constituted of a plurality of catalyst units 17 arranged at specified intervals along the width direction of the vehicular body (right and left directions, in Fig. 2); a supporter 18 interposed between the catalyst unit group U and the casing 14; and a spacer 19 interposed between the adjacent catalyst units 17 in the array direction.

The catalyst unit 17 fabricated using a corrugator or the like (not shown) has a such structure that a plurality of flat sheet members 20 and corrugated sheet members 21 are alternately laminated to form a plurality of reaction passages 22. These flat sheet member 20 and corrugated sheet member 21 constitutes a carrier, each of which is formed of a heat resisting alloy of an iron-chromium-aluminum system having a thickness of

40 to 50  $\mu\text{m}$ , and the abutted portions thereof are integrally joined by means of a brazing filler material of a nickel-chromium system.

Also, on the surfaces of these flat sheet member 20 and the corrugated sheet member 21 constituting the carrier, an oxidation catalyst such as platinum or palladium (not shown) is carried. With this construction, in the course of time when the exhaust gas passes through reaction passages 22, the oxidation reaction for the unburnt component such as harmful hydrocarbon in the exhaust gas discharged from the combustion chamber 7 of the engine 6 is activated by the oxidation catalyst, and thereby the exhaust gas is made harmless.

In this embodiment, the material for the catalyst units 17 is fabricated in a continuous strip shape using a corrugator or the like, and is folded for each specified length in a zigzag shape, to thus form the catalyst unit group U by making the material for the catalyst units 17 being multi-staged. In addition, the above folded portion 23 constitutes a unit connecting means of the present invention.

The above supporter 18 serving as an insulating support layer of the present invention is made of an inorganic cushioning material having a thermal insulating property in combination with an electric insulating property such as "Interam/mat" sold by 3M Co., Ltd (U.S) for stably supporting the catalyst unit group U in the casing 14.

Also, the above spacer 19 held between the adjacent catalyst unit 17 is intended to hold the catalyst units 17 at a specified interval and to prevent the adjacent catalyst units 17 from being electrically shortened without passing through the folded portion 23, and which is made of cordierite or the like used as a ceramic system catalyst carrier having an electric insulating property. The spacer 19 in this embodiment is interposed between the adjacent catalyst units 17 over the whole region in the height direction. However, it may be interposed between the catalyst units 17 only at upper and lower end portions thereof, and the remaining gap portions may be used as the reaction passages.

A pair of electrodes 27 project from the right and left sides of the lower end portion of the casing 14 to pass through the supporter 18 and the casing 14. The central portion of an electrode connecting rod 28 extending in parallel to the reaction passage 22 is integrally connected to the base end of each electrode 27. A connecting groove 29 is formed on the electrode connecting rod 28 along the longitudinal direction thereof. Each of connecting portions 30, which are respectively formed by pressing at the lower end portions of the catalyst units 17 positioned on the right and left sides of the casing 14, is inserted into the connecting groove 29, and

which is integrally joined to the electrode connecting rod 28 through the brazing filler material (not shown).

A lock nut 33 is screwed in a hollow bolt 31, through which the electrode 27 passes to be locked with the casing 14, through a washer 32. The electrode 27, the hollow bolt 31 and the lock nut 33 are seal-welded to each other at the weld 34, to thereby certainly seal the interior of the casing 14. These electrode 27, electrode connecting rod 28, hollow bolt 31, washer 32, lock nut 33 are made of nickel or the like having an excellent heat resistance. Around an electrode through-hole 35 of the casing 14 through which the hollow bolt 31 passes, a pair of seal washers 36 and an insulating ring 37 made of artificial mica, ceramic or the like are interposed. In other words, the inside and the outside of the casing 14 are held by the hollow bolt 31 and the lock nut 33 through the seal washers 36 and the insulating ring 37 having the electric insulating property, so that the electrode 27 is fixed to the casing 14.

In addition, at the leading edge of the electrode 27, a terminal 39 connected to a power supply 5 as shown in Fig. 22 is fixed by a pair of flanged nuts 38 screwed in the electrode 27. Also, on the downstream side of the casing 14, there is provided a temperature sensor 40 using a thermocouple or the like for detecting the temperature of the catalyst units 17.

Accordingly, in the state that the ignition key is turned on, when an electronic control unit (not shown) judges that the detection signal from the temperature sensor 40 is, for example less than 300°C, that is, the oxidation catalyst of the auxiliary catalytic converter 13 is not activated, a current is supplied from the power supply 5 to the electrode 27 through the terminal 39. The current is allowed to flow from the catalyst unit 17 on one end side in the width direction of the vehicular body to the catalyst unit 17 on the other end side in the zigzag manner, so that the catalyst units 17 are heated to activate the oxidation catalyst. On the other hand, when the electronic control unit judges that the detection signal from the temperature sensor 40 is, for example 300°C or more, that is, the oxidation catalyst of the auxiliary catalyst converter 13 is already activated, the engine 6 is started and the unburnt component in the exhaust gas is burnt by the auxiliary catalytic converter 13. Subsequently, when the three way catalyst of the main catalytic converter 1 is activated, the current to the auxiliary catalytic converter 13 is stopped, and the purification of the exhaust gas is made mainly by the main catalytic converter 1.

In this case, it is possible to remarkably increase the current passage length of the carrier in the auxiliary catalytic converter 13. This makes it



possible to increase the absolute heat generation amount without changing the capacity of the power supply 5 by increasing the supply voltage to the auxiliary catalytic converter 13, and hence to activate the oxidation catalyst for a short time.

Here, there will be described the concrete system for increasing the supply voltage to the auxiliary catalytic converter 13 with reference to Fig. 4. In addition, parts substantially corresponding to those in the prior art exhaust gas purifying apparatus as shown in Fig. 22 are indicated at the same characters, and the explanation thereof is omitted. Fig. 5 is a time chart showing the relationship among series/parallel switching of batteries 100 and 101, switching of the catalyst switch 102 for controlling the current-carrying to the auxiliary catalytic converter 13, and ON/OFF switching of the ignition key. In the state that the ignition key is turned on, the current-carrying time is obtained from the current-carrying time characteristic previously set as shown in Fig. 6 on the basis of the detection signal from the temperature sensor 40.

Also, when the ignition key is turned on, the electronic control unit (not shown) concurrently operates a relay 103 to switch the batteries 100 and 101 from the parallel to the series state. Namely, when the contacts "a" and "c" of the relay 103 constituted of moving contacts are made in the contact states (as shown in the solid line), the parallel circuit is obtained. On the other hand, when the movable contacts are moved in the direction of the arrow, and the contact "b" is made in the contact state (as shown in the broken line), the series circuit is obtained.

After that, when the ignition key is set to be in the cranking state and the engine is started, the high voltage in the series state is supplied by turning on the catalyst switch 102. At the same time when the catalyst switch 102 is turned on, a timer is started. Then, after an elapse of a specified current-carrying time previously set on the basis of Fig. 6, the catalyst switch 102 is turned off and concurrently the batteries are switched from the series to the parallel state. Each of the batteries 100 and 101 comprises an on-vehicle 12V battery.

As described above, it is possible to remarkably increase the current passage length of the carrier of the auxiliary catalytic converter 13, and to increase the supply voltage to the auxiliary catalytic converter 13. This makes it possible to activate the auxiliary catalytic converter 13 for a short time.

In addition, in this embodiment, the catalyst units 17 are arranged along the width direction of the vehicular body; however, the catalyst units 17 arranged in the vertical direction of the vehicular body may be further connected to each other in series along the flow direction of the exhaust gas.

According to the exhaust gas purifying catalytic converter of this embodiment, by arrangement of the flat catalyst units in the laminated state, it is possible to avoid the enlargement of the size of the catalytic converter.

Also, both end portions of these catalyst units are alternately connected to each other by the unit connecting means, so that a current is allowed to flow in the zigzag manner. As a result, the current passage of the carrier is increased, to thereby increase the absolute heat generation. Therefore, by increasing the supply voltage to the catalytic converter, it is possible to activate the catalyst for a short time without increasing the capacity of the power supply.

Next, there will be described a method of fabricating a catalyst unit group U according to a second aspect of the present invention with reference to Figs. 7 to 12.

As shown in Figs. 7 to 9 showing the fabrication procedure of the catalyst unit group U of the present invention, each folded portion 23 of a sheet-like material for the catalyst units 17 is crushed between a die 24 and a punch 25 (see Fig. 7); a core bar 26 is contacted with the plastically deformed folded portion 23 on the die 24 side (see Fig. 8); the leading edge side of the material for the catalytic units 17 is folded at 180° along the core bar 26 with respect to the core bar 26 (see Fig. 9); and the core bar 26 is withdrawn, to thus form the folded portion 23.

In addition, assuming that the ratio of the circumference of a circle to its diameter is taken as  $\pi$  and the radius of the core bar 26 is taken as "r", it is preferable that the crush allowance W of the material for the catalyst units 17 by the punch 25 is set at  $\pi \times r$  or more, and the radius "r" of the core bar 26 is set at 0.5mm or more (namely, the thickness of the spacer 19 is 1mm or more). Also, naturally, the core bar 26 may be integrally joined to the folded portion 23 of the material for the catalytic units 17 as it is.

In this embodiment, only one side surface of the sheet-like material for the catalyst units 17 is crushed by the punch 25; however, both sides thereof may be crushed. For example, as shown in Figs. 10 to 12 showing the fabrication procedure of the other form of the method of fabricating the catalyst unit group according to the present invention, a folded portion 41 of the sheet-like material for the catalyst units 17 is uniformly crushed by a pair of punches 42 and 43 (see Fig. 10); the core bar 26 is contacted with one of the plastically deformed folded portions 41 (see Fig. 11); the leading edge side of the material for the catalyst units 17 is folded at 180° along the core bar 26 with respect to the core bar 26 (see Fig. 12); and the core bar 26 is withdrawn, to thus form the

folded portion 41.

In this case, the folded portion 41 is in the state being wound around the core bar 26 at 180° or more, so that it is possible to enhance the mechanical strength of the folded portion 41 as compared with the folded portion 23 in the previous form as shown in Figs. 7 to 9.

According to the second invention, the catalyst unit group U can be fabricated only by pressing or folding without adoption of the welding or the like, which makes it possible to avoid the enlargement of the size of the catalytic converter, and hence to reduce the production cost.

#### Embodiment 2

Next, a second embodiment will be described with reference to Fig. 13.

First, there is prepared a catalyst unit group U<sub>2</sub> in the state being rotated at 90° with respect to the catalyst unit group U<sub>1</sub> described in the first embodiment. The catalyst unit 17 on one end side of the catalyst unit group U<sub>1</sub> is connected in series to the catalyst unit 17 on one end side of the catalyst unit group U<sub>2</sub> by means of a long-sized unit connecting rod 41 having substantially the same construction as the electrode connecting rod 28 described above. On the other hand, the catalyst unit 17 on the other end side of the catalyst unit group U<sub>1</sub> is connected to the catalyst unit 17 of the catalyst unit group U<sub>2</sub> by means of each electrode connecting rod 28 with the projecting electrode 27.

In this case, by formation of a gap between the catalyst unit group U<sub>1</sub> and the catalyst unit group U<sub>2</sub>, the current passage length of the carrier becomes twice as much as that of the first embodiment, thereby further increasing the supply voltage to the catalytic converter. This makes it possible to further increase the amount of generated heat of the catalytic converter without increasing the capacity of the power supply 5.

#### Embodiment 3

Also, a third embodiment is shown in Figs. 14 and 15.

In the second embodiment as shown in Fig. 13, the catalyst unit groups U<sub>1</sub> and U<sub>2</sub> are connected to each other by means of one of the unit connecting rod 41. On the contrary, in this embodiment, as shown in Fig. 14 showing an appearance of the other form of an exhaust gas purifying catalytic converter of the present invention, and Fig. 15 showing an appearance of the part of the catalyst unit of the catalytic converter of Fig. 14 in the exploded state, unit connecting rods 43 integrally formed with terminals 42 projecting from the casing 14 to the outside are fixed to the catalyst unit

groups U<sub>1</sub> and U<sub>2</sub>, respectively. These terminals 42 may be electrically connected to each other by a connecting fitting 44 outside the casing 14. Also, in these figures, parts corresponding to those in the first embodiment as shown in Figs. 1 to 6 are indicated at the same characters.

#### Embodiment 4

Next, there will be described a fourth embodiment wherein the casing 14 is formed in a circular or polygonal shape in section with reference to Figs. 16 to 18.

The casing 14 in this embodiment comprises a portion having a circular appearance for storing the catalyst units 17, and a pair of portions each having a conical appearance and respectively connected to the connection flanges 15 and 16. In this casing 14, there are stored a plurality of catalyst units 17 arranged in specified intervals along the width direction of the vehicular body (right and left directions, in Fig. 2), the supporter 18 interposed between the catalyst units 17 and the casing 14, and the sheet-like spacers 19 each interposed between the adjacent catalyst units 17 in the array direction.

Thus, by formation of the casing 14 in a circular shape in section, it is possible to ununiformly distribute the holding force to the catalyst units 17 and the like stored in the casing 14, and hence to minimize the risk that each catalyst unit 17 is damaged by the application of the uneven load.

The parts substantially corresponding to those of the first embodiment are indicated with the same characters, and the explanation thereof is omitted.

Also, Fig. 18 shows a casing 14 having a hexagonal sectional shape.

As shown in this figure, in a pair of the right and left halves of the casing 14 each having a trapezoidal shape, both the upper and lower end portions thereof are seam-welded to each other to form the casing 14 as a hexagonal cylinder, in which the catalyst units 17 and the like are tightly stored according to the shape of the inner peripheral wall of the casing 17. In this case, it is preferable to form each folded portion 23 in parallel to the inner peripheral wall of the casing 14. In addition, just as the first embodiment, the strip-like material for the catalyst units 17 is folded in the zigzag manner in the state that the plate-like core bar is mounted to each the folded portion 23.

#### Embodiment 5

Next, a fifth embodiment will be described with reference to Figs. 19 to 21.

The fifth embodiment refers to a method of fabricating the catalyst unit group U to be disposed in the casing 14 with a circular or polygonal shape



as described in the fourth embodiment.

Each folded portion 23 of a strip-like material for the catalyst units 17 is crushed between a pair of a die 24 and a punch 25 (see Fig. 19); a core bar 26 is contacted with the plastically deformed folded portion 23 on the die 24 side (see Fig. 20); the leading edge side of the material for the catalyst units 17 is folded at 180° along the core bar 26 with respect to the core bar 26 (see Fig. 21); and the core bar 26 is removed, to thereby form the folded portion 23.

The outer peripheral surface (right side surface, in Fig. 20) of the core bar 26 abutted on the folded portion 23 has a circular-arc section having a curvature corresponding to that of the casing 14, and the inclined angle of the core bar 26 to the material for the catalyst units 17 is set according to the position of the folded portion 23 with respect to the casing 14. Also, the core bar 26 may be integrally joined to the folded portion 23 of the material for the catalyst units 17 as it is.

In this embodiment, it is possible to form each folded portion 23 in parallel to the inner peripheral wall of the casing 14.

## Claims

1. An exhaust gas purifying catalytic converter comprising:

a plurality of catalyst units (17) arranged to be spaced in parallel to each other in the direction crossing to the flow direction of the exhaust gas of an internal combustion engine (6),

unit connecting means (23) for connecting one-end sides of said catalyst units (17) to the other end sides of adjacent catalyst units (17) in the direction transverse to the array direction of said catalyst units (17) and to the flow direction of said exhaust gas so as to be alternate along said array direction;

a casing (14) for surrounding a plurality of said catalyst units (17); and

a pair of electrodes (27) which are electrically connected to two catalyst units positioned at both ends in said array direction, and which pass through said insulating support layer (18) and said casing (14) to be arranged outside said casing (14) and to be connected to a power supply (5).

2. The catalytic converter of claim 1, wherein each of said catalyst units (17) has a conductive carrier forming a plurality of reaction passages (22) for introducing said exhaust gas, and a catalyst fixed on the surface of said carrier in said reaction passages (22), and which is formed by alternately laminating flat

sheet members (20) and corrugated sheet members (21).

3. The catalytic convertor of claim 1 or 2, wherein the end portion of said catalyst unit (17) connected to said electrode (27) has a connecting portion (30) crushed by pressing, an electrode connecting member (28) is connected to said connecting portion (30), and the base end portion of said electrode (22) is connected to said electrode connecting member (28).

4. The catalytic converter of claim 1, wherein a plurality of catalyst unit group ( $U_1$ ,  $U_2$ ), each being constituted of a plurality of said catalyst units (17), are arranged along the flow direction of said exhaust gas, and one electrode of one catalyst unit group ( $U_1$ ) is connected in series to one electrode of the adjacent catalyst unit group ( $U_2$ ).

5. The catalytic converter of any of claim 1 to 4, wherein spacer (19) having an electric insulating property are interposed in gaps between adjacent said catalyst units (17).

6. The catalytic converter according to claim 5, wherein said spacers (19) are interposed between both ends of said catalyst units (17) on the side provided with said unit connecting means (23) and an insulating support layer (18) surrounding said catalyst units (17), and each of said spacers (19) has a projecting portion to be inserted between said adjacent catalyst units (17) to form an air insulating layer corresponding to the thickness of said projecting portion between said catalyst units (17).

7. The catalytic converter of any of claim 1 to 6, wherein said casing (14) is formed in a circular or polygonal sectional shape, and said catalyst units (17) are tightly arranged in said casing (14) in a laminated state.

8. A method of fabricating an exhaust gas purifying catalytic converter comprising the steps of:  
crushing a catalyst carrier having a strip-like honeycomb structure, in which a plurality of reaction passages (22) are formed in parallel to each other, for each interval in the direction parallel to said reaction passages; and

folding said crushed portions alternately in the reversed direction at approximately  $180^\circ$ , thereby arranging said catalyst carrier (17) in a zigzag manner.

9. The method of fabricating the catalytic converter of claim 8, which further comprises the steps of:
- crushing only one surface side of said catalyst carrier; 5
  - contacting a core bar (26) with the other surface side not to be crushed;
  - folding said catalyst carrier along said core bar (26) with respect to said core bar at approximately  $180^\circ$ , thereby forming said folded portion. 10
10. The method of fabricating the catalytic converter of claim 8, which further comprising the steps of: 15
- crushing both surfaces of said catalyst carrier;
  - contacting a core bar (26) with any one of said crushed surfaces;
  - folding said catalyst carrier along said core bar (26) with respect to said core bar at approximately  $180^\circ$ , thereby forming said folded portion. 20
11. The method of fabricating the catalytic converter of claim 9 or 10, wherein a casing for storing said multi-layer catalyst carrier is provided, and the outer peripheral shape of said core bar is set in such a manner that the folded shape of said folded portion correspond 25  
30  
35  
40  
45  
50  
55

FIG.1

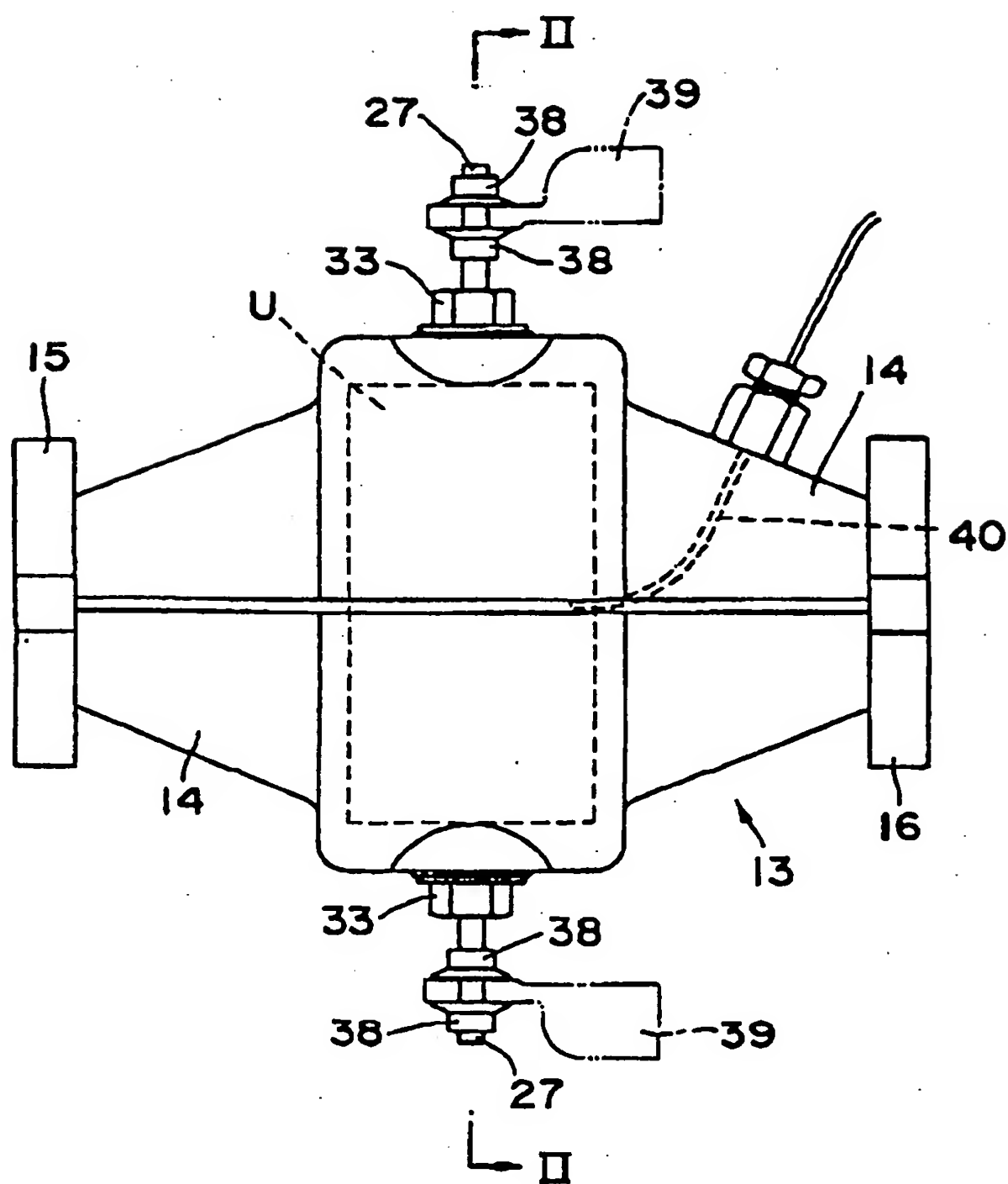


FIG.2

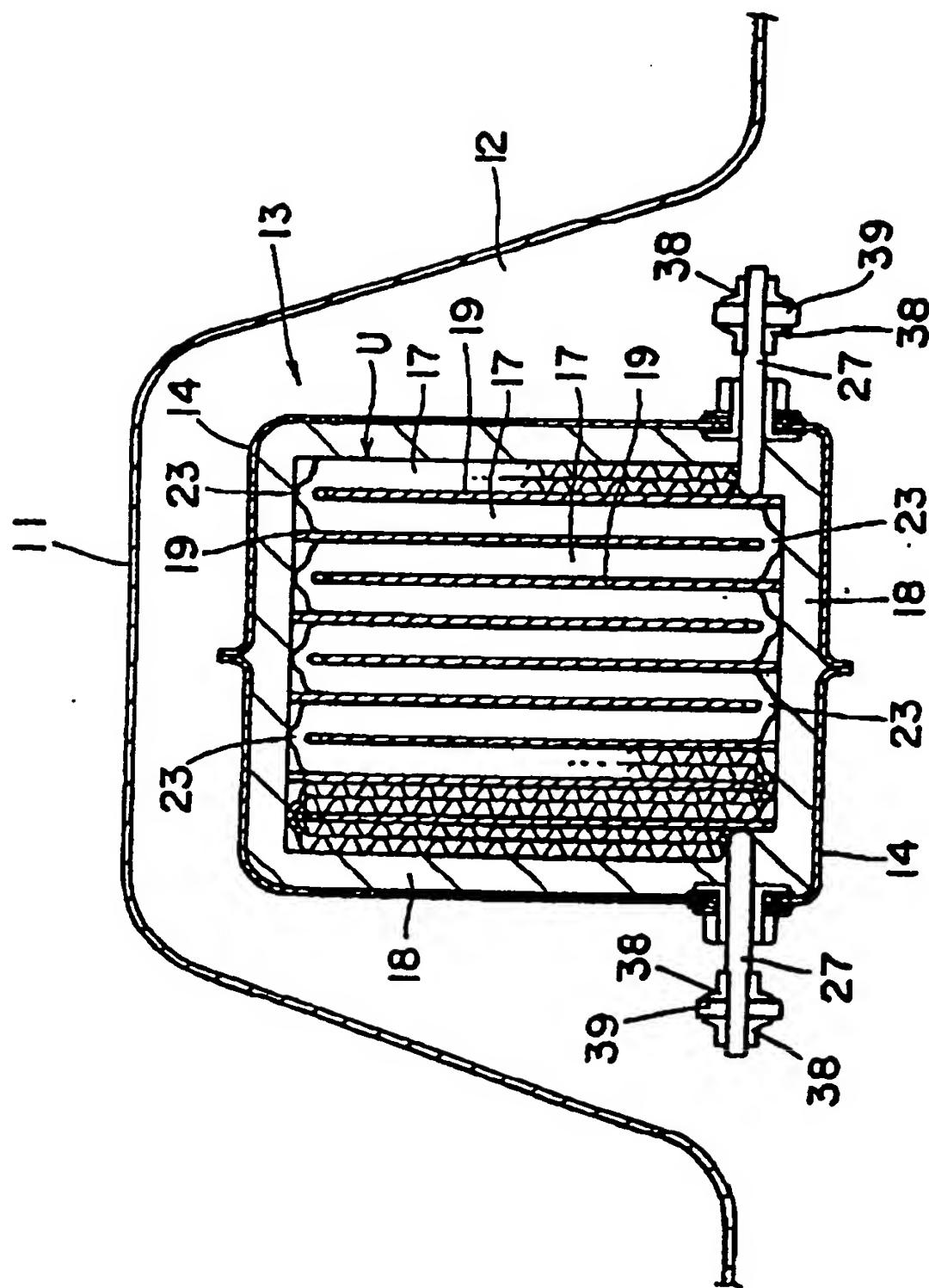


FIG.3

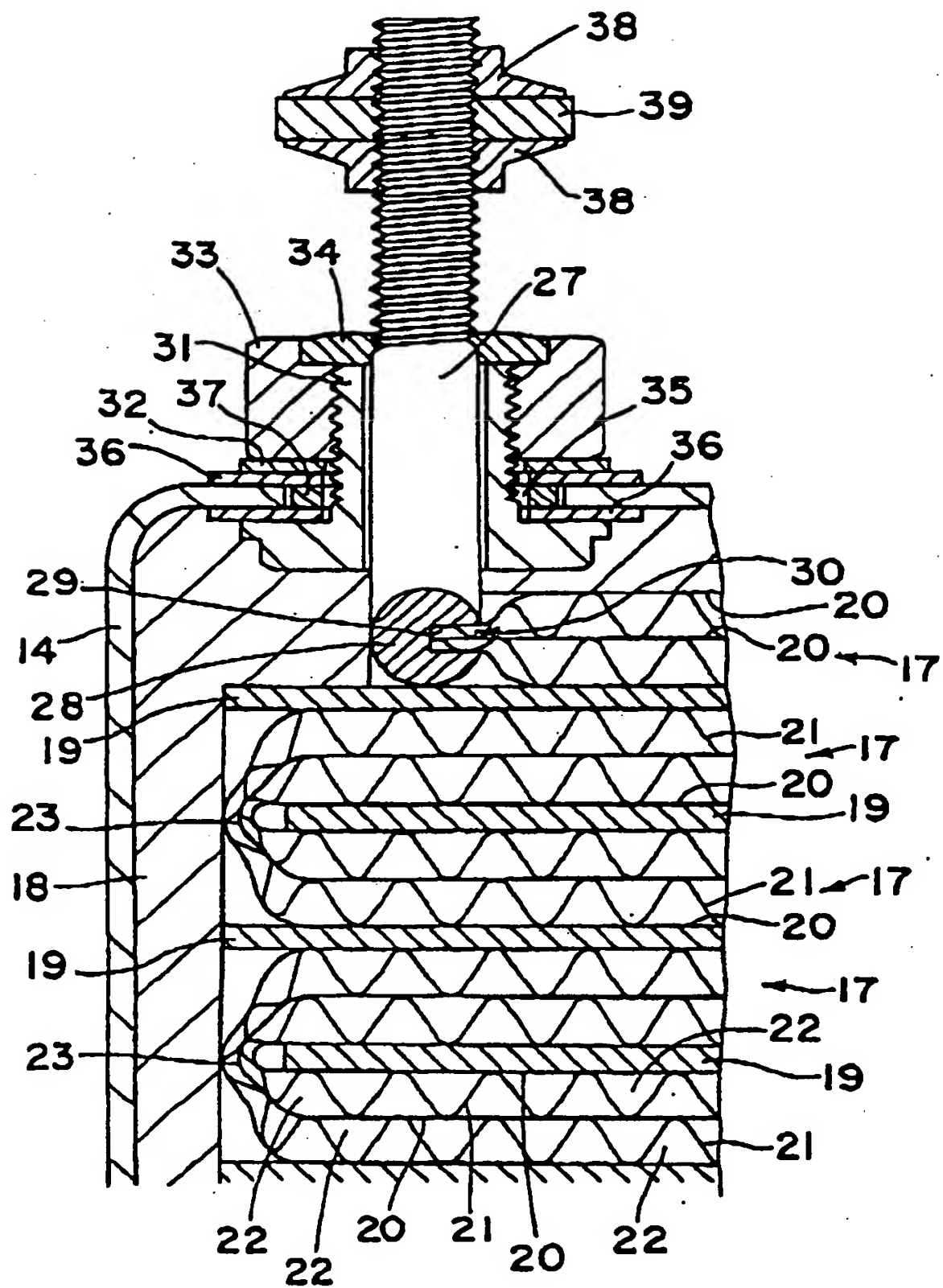




FIG. 4

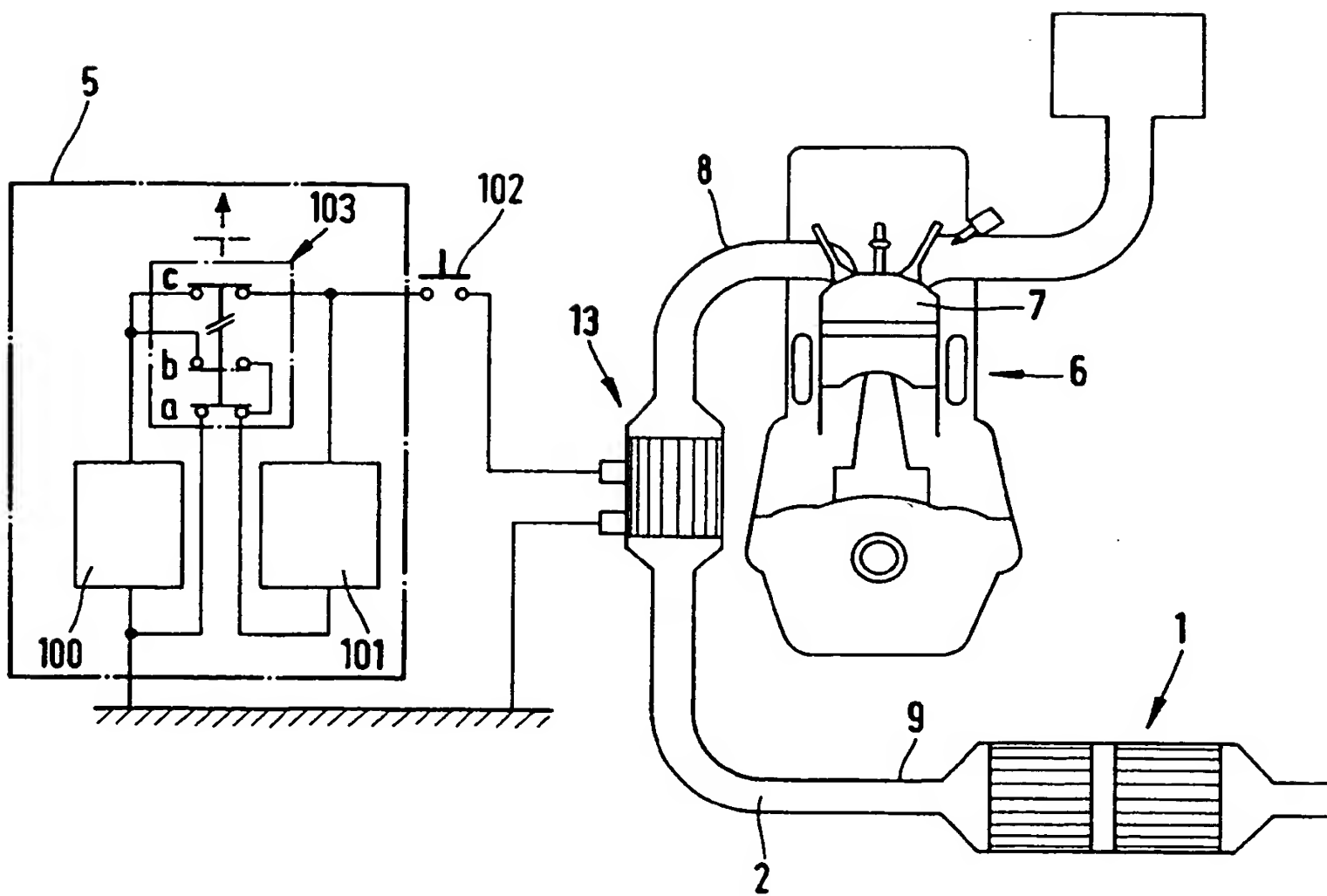


FIG. 5

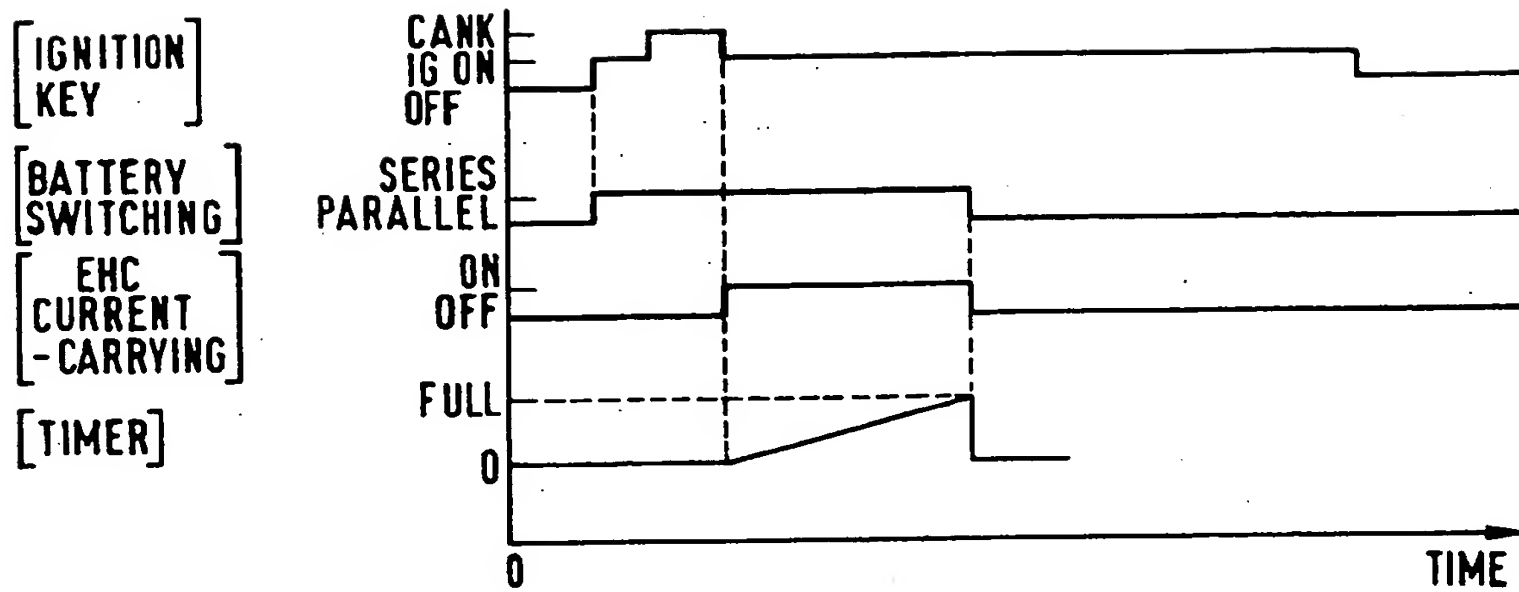


FIG. 6

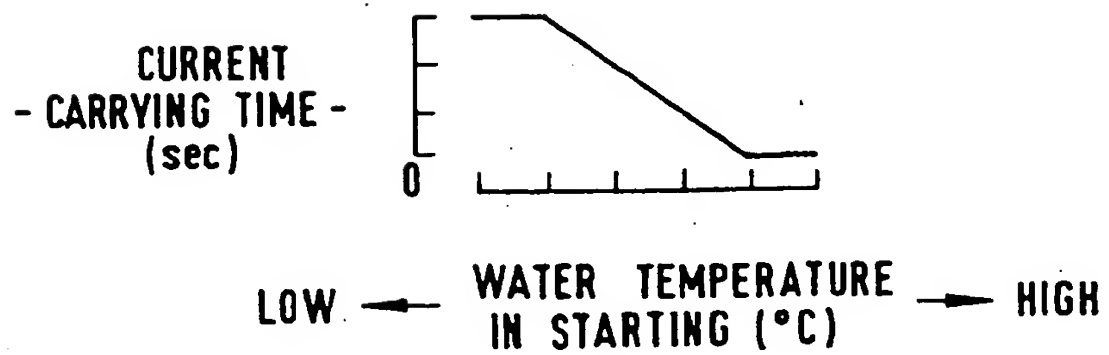


FIG.7

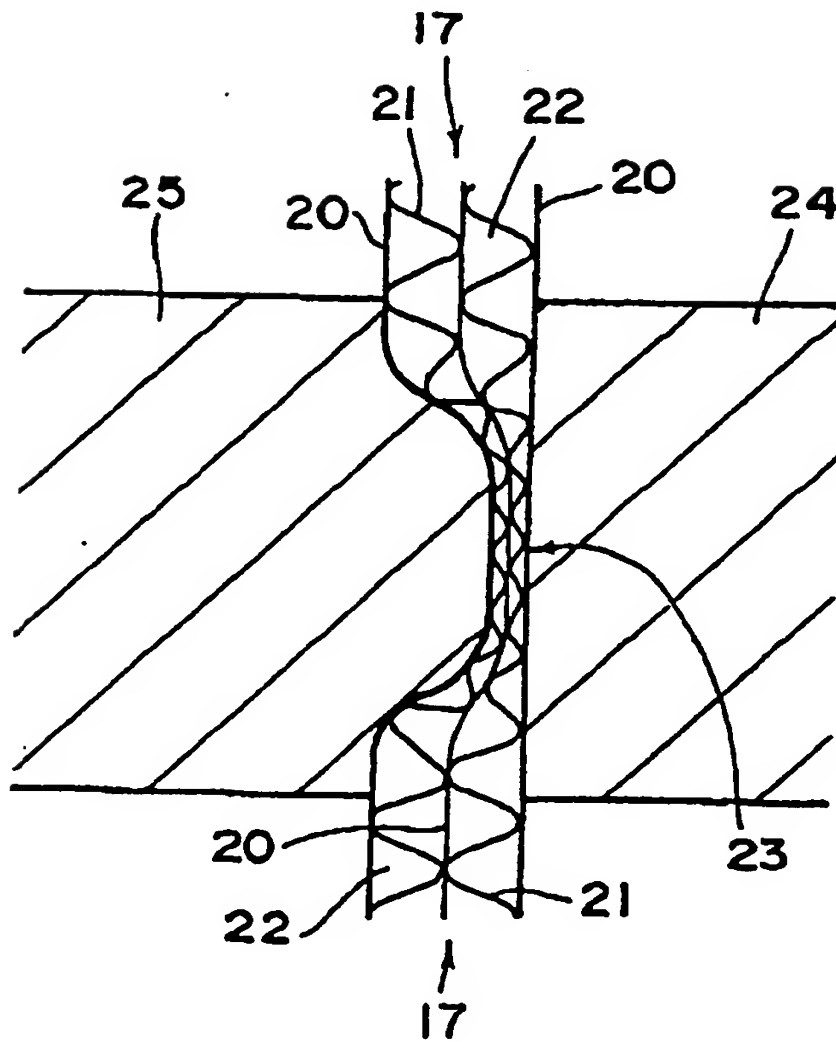


FIG.8

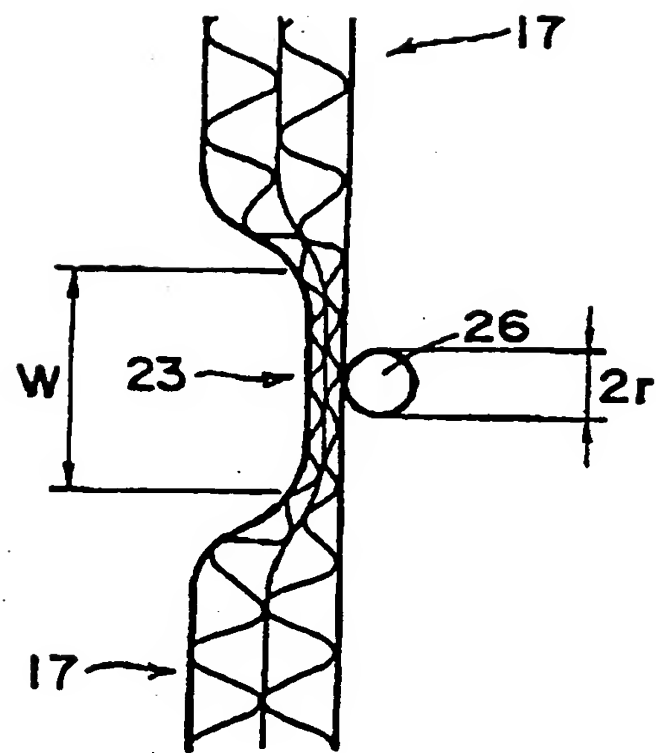


FIG.9

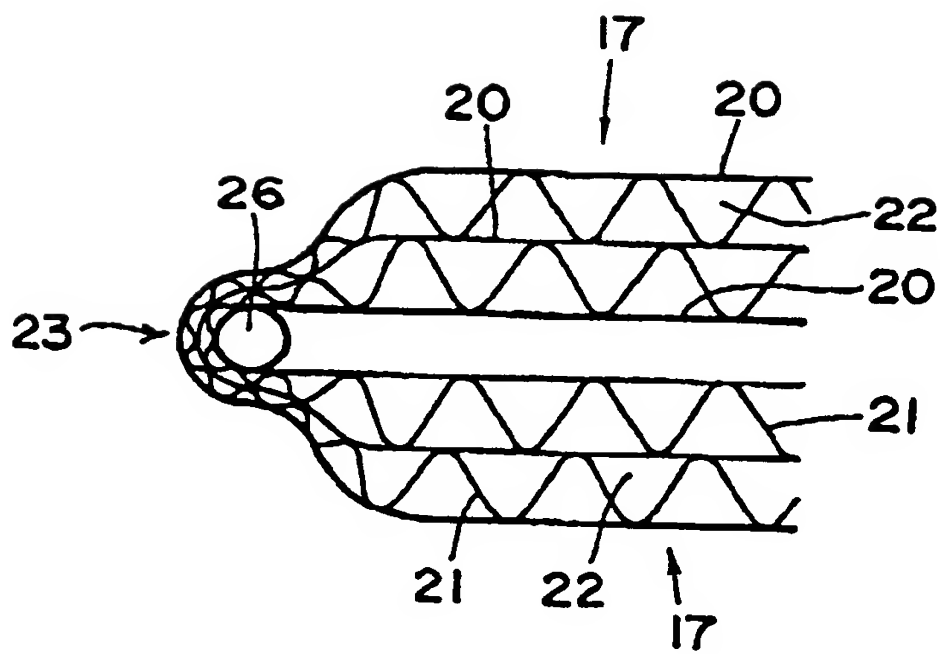




FIG.10

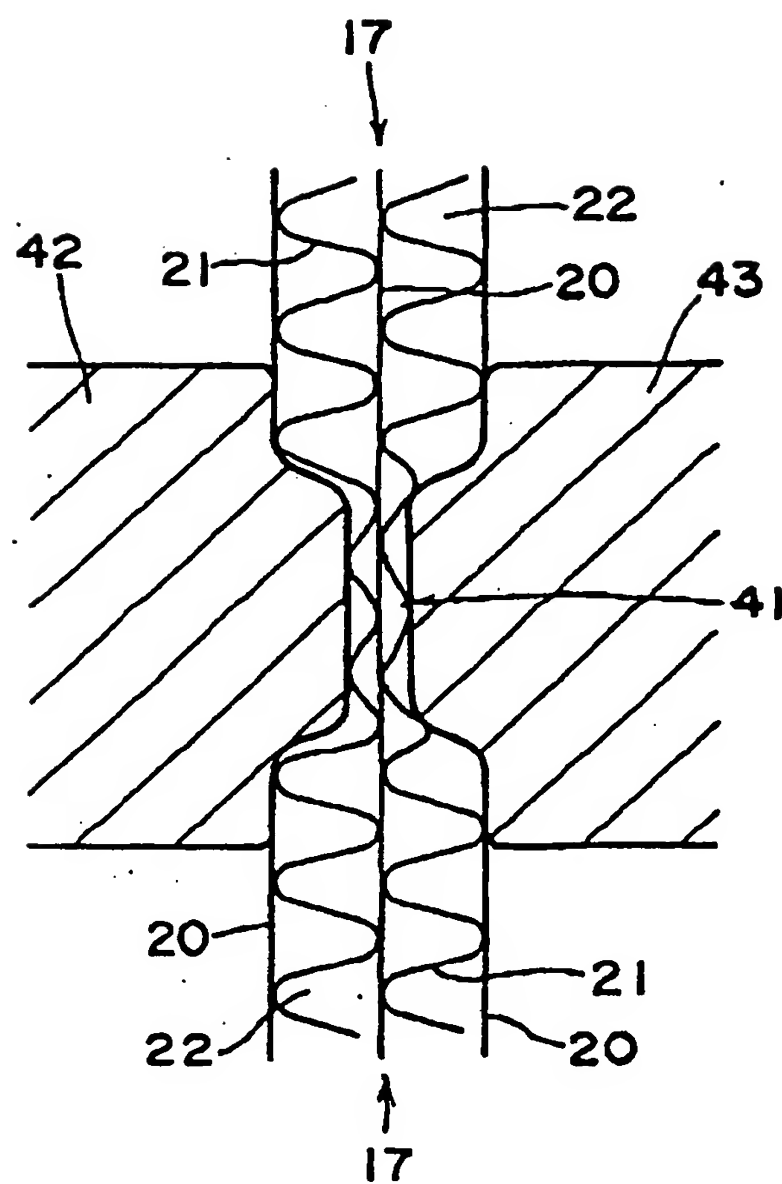


FIG.11

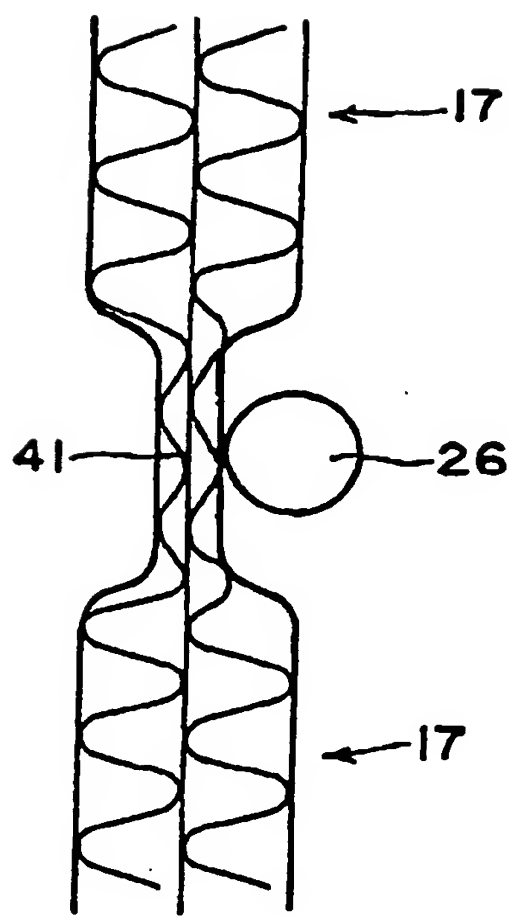


FIG.12

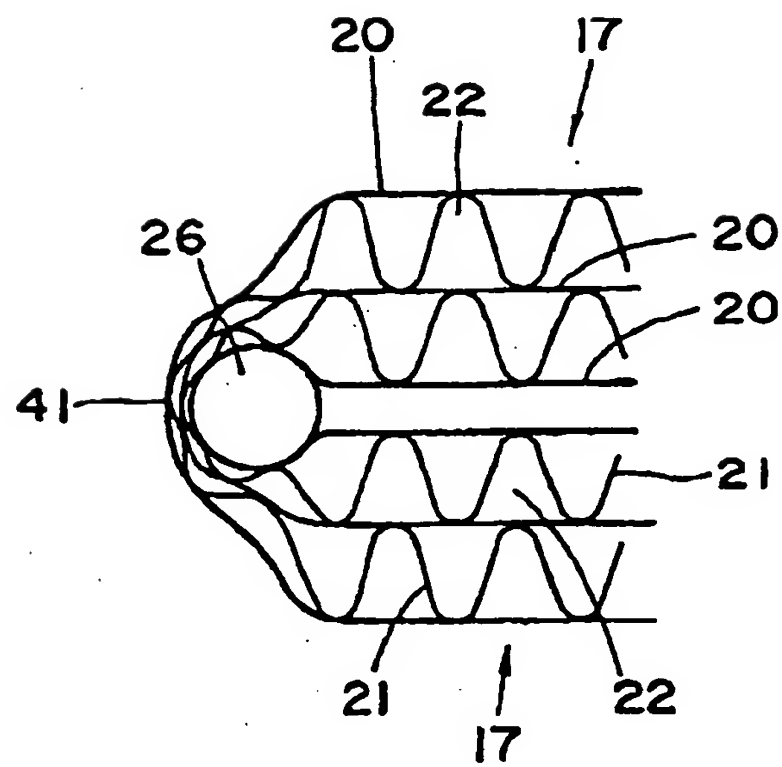




FIG.14

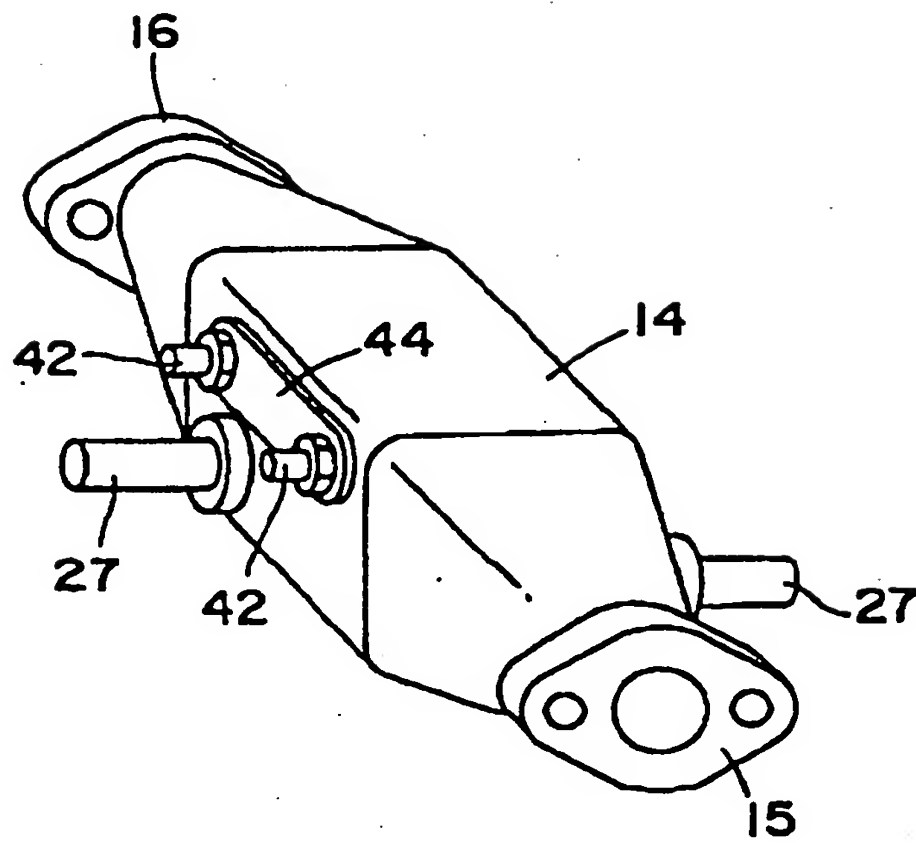
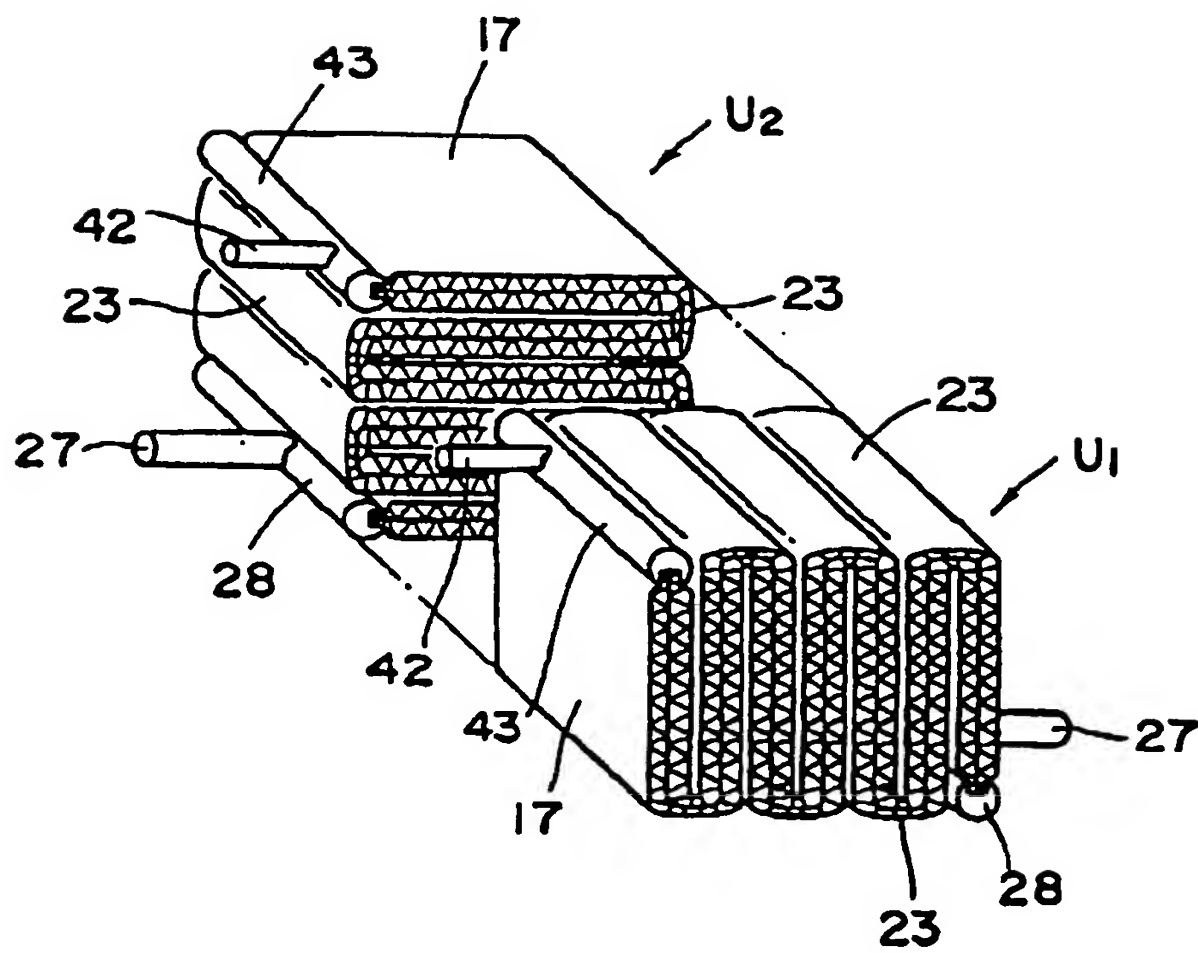




FIG.15



91517

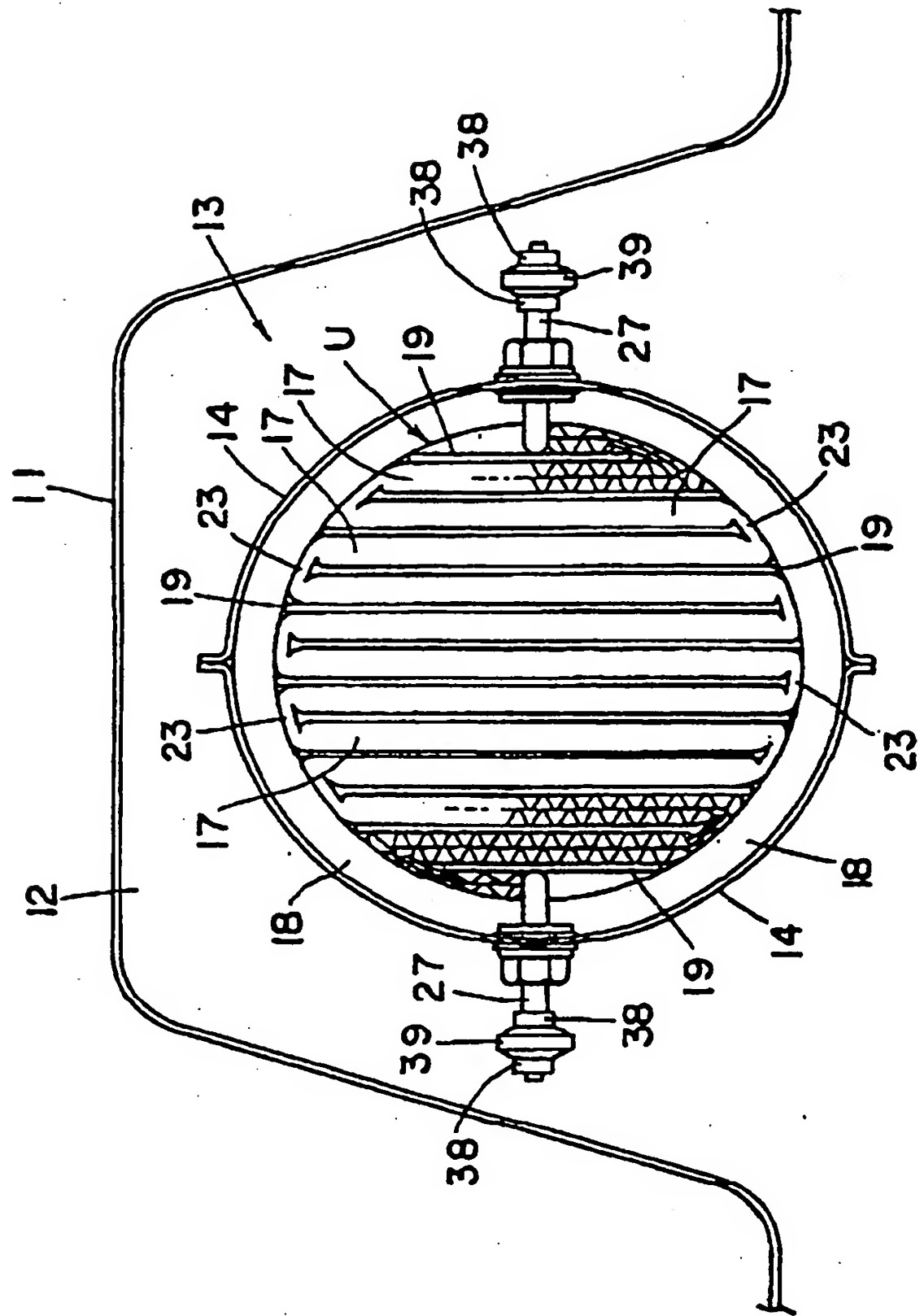


FIG.17

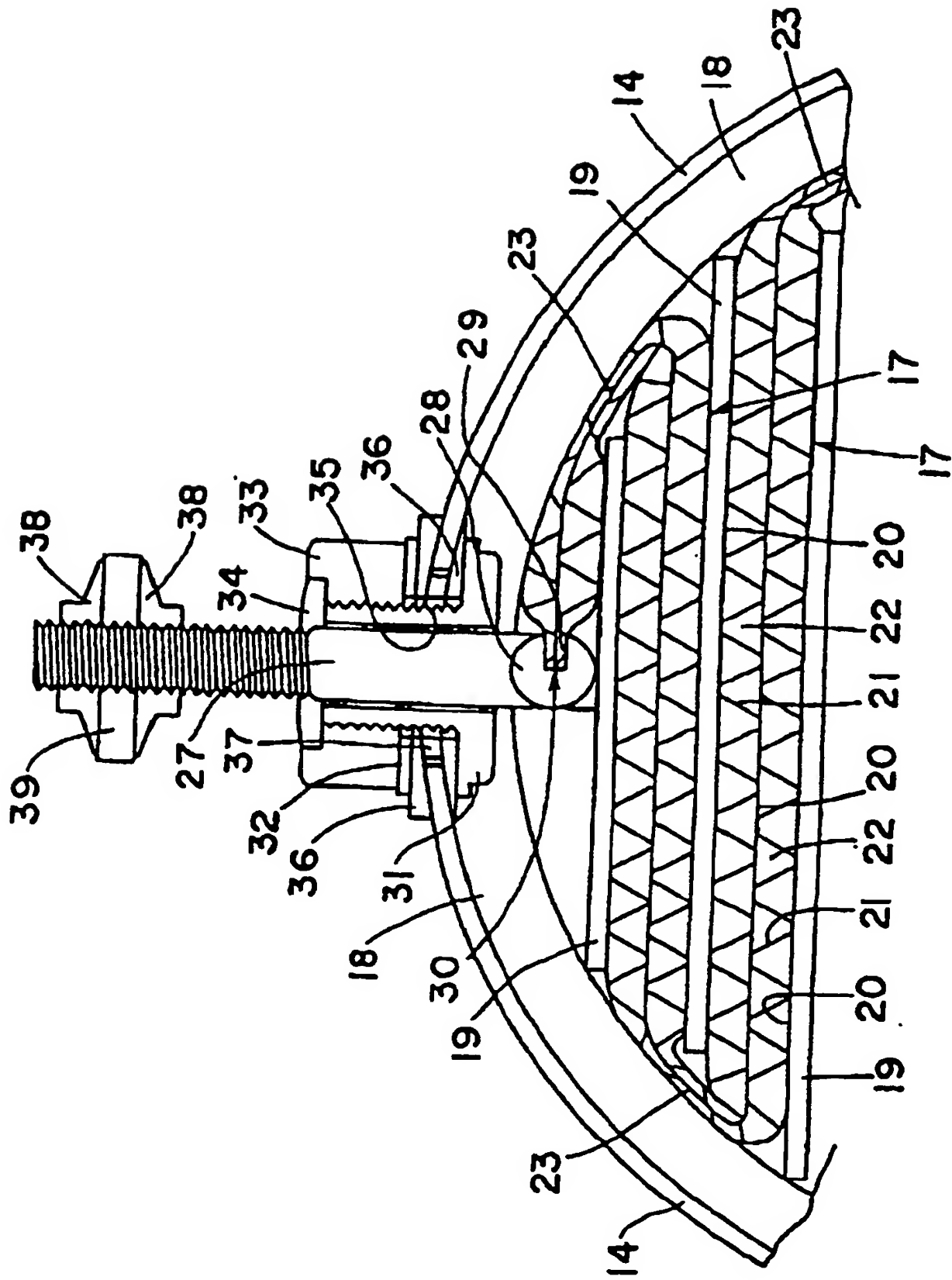


FIG. 18

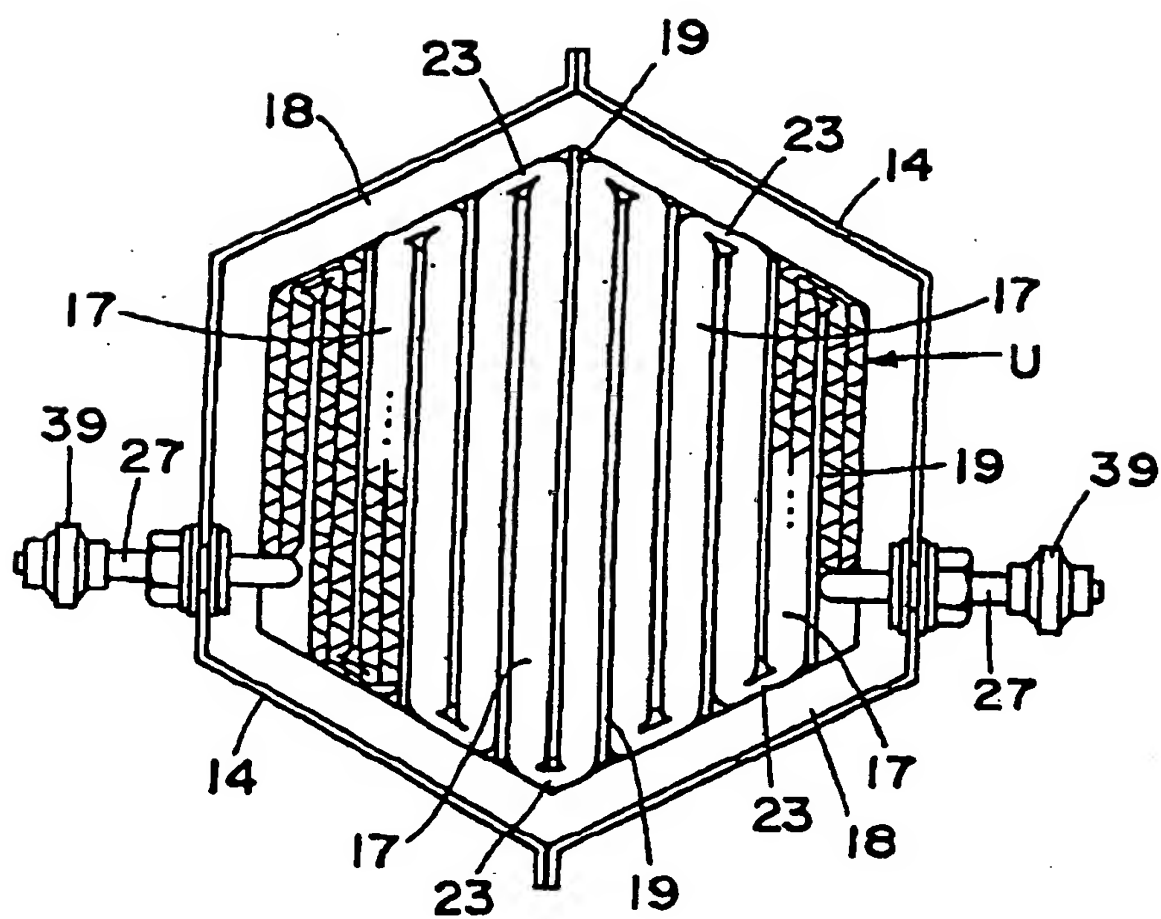


FIG.19

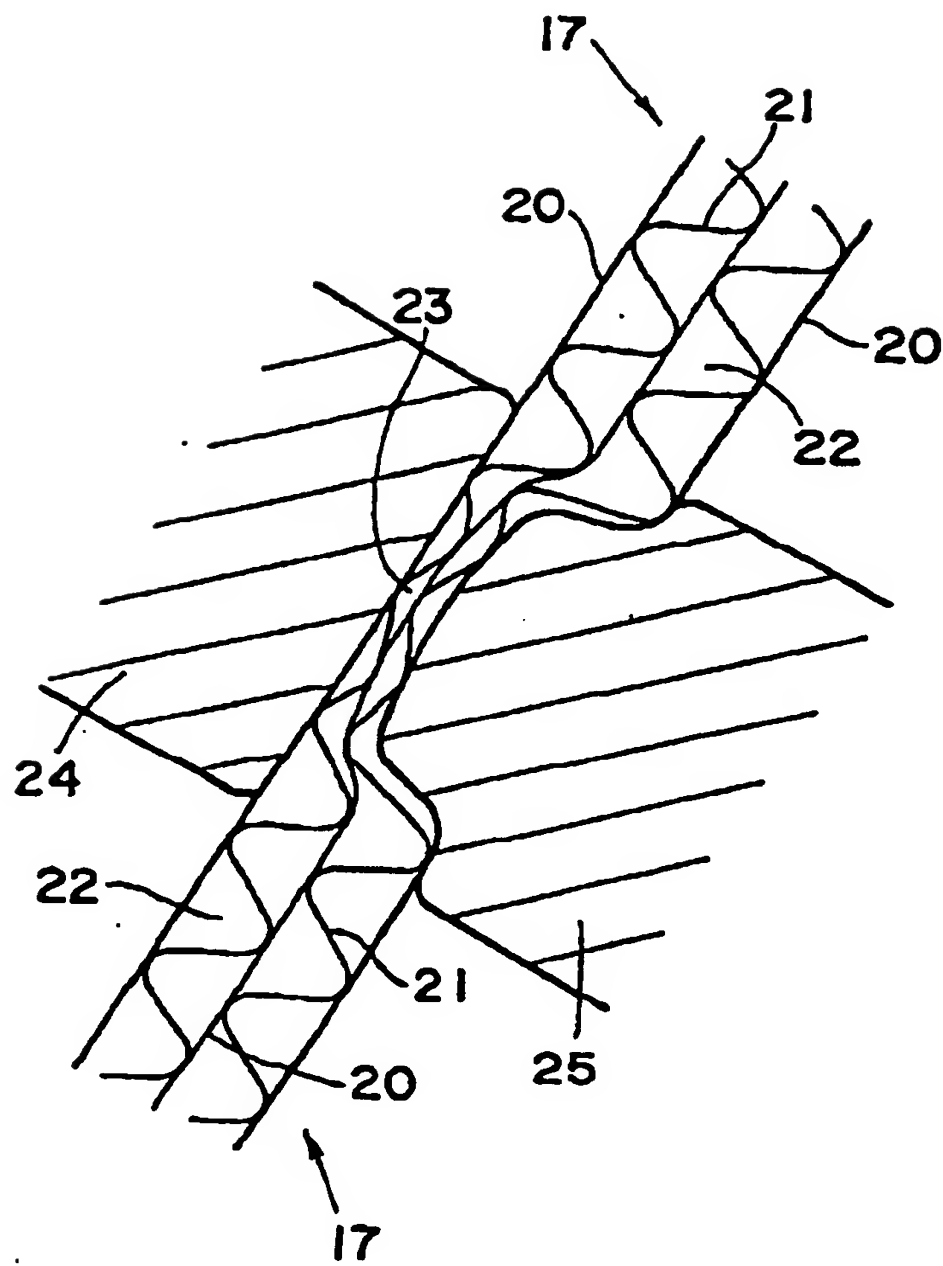




FIG.20

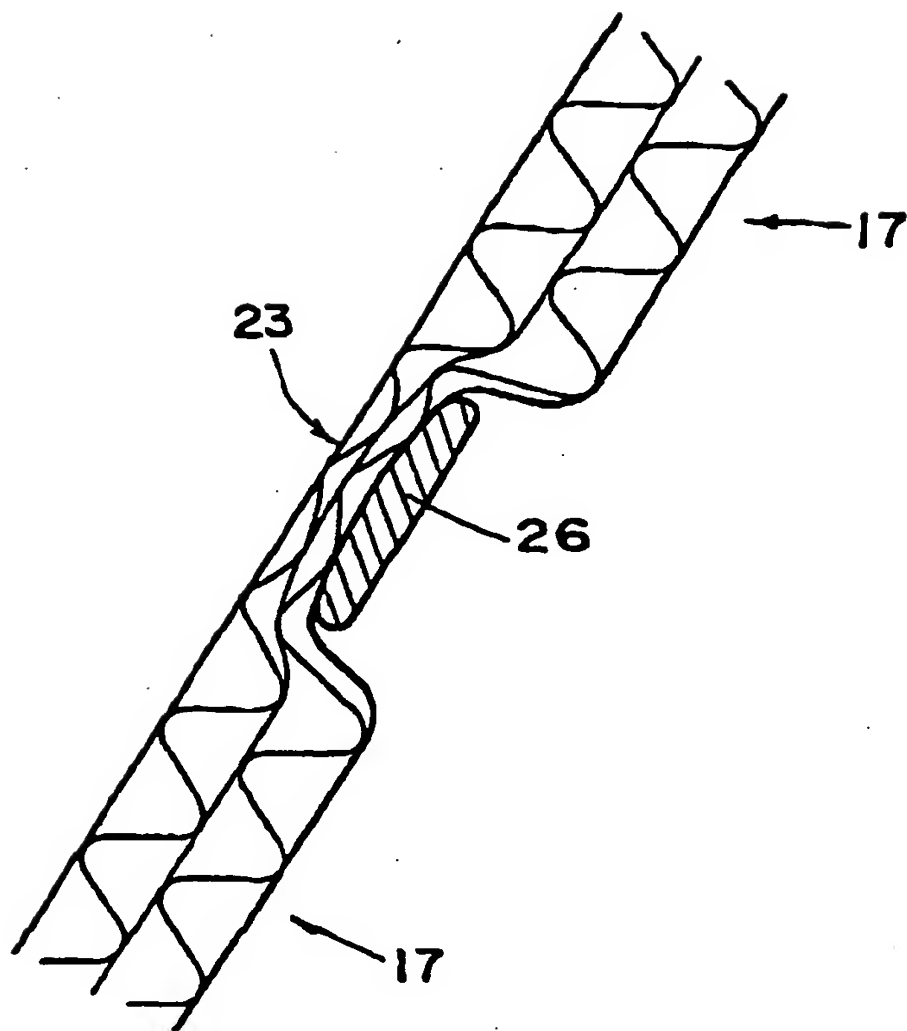


FIG. 21

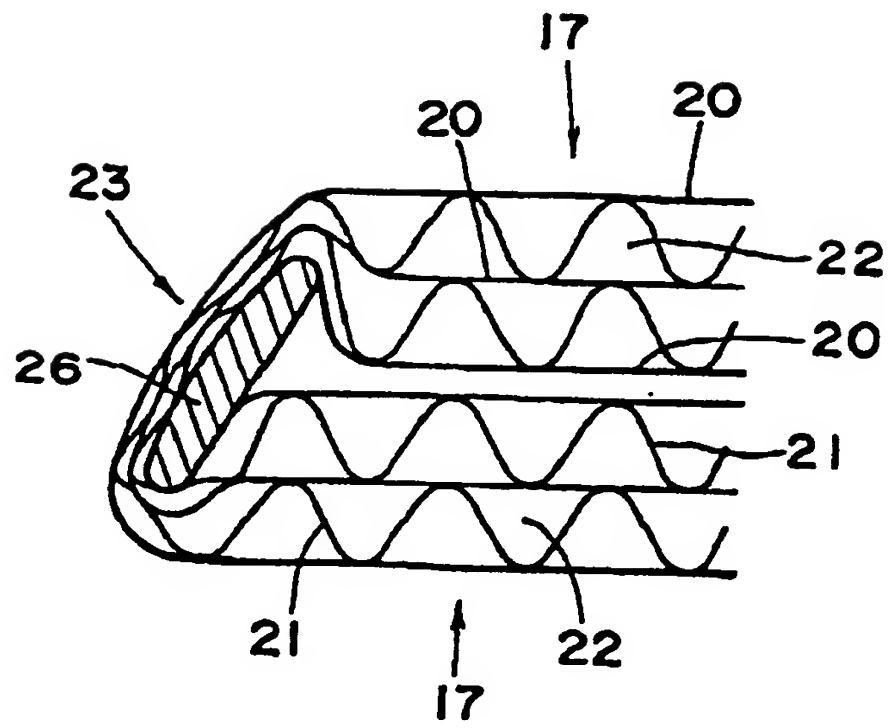
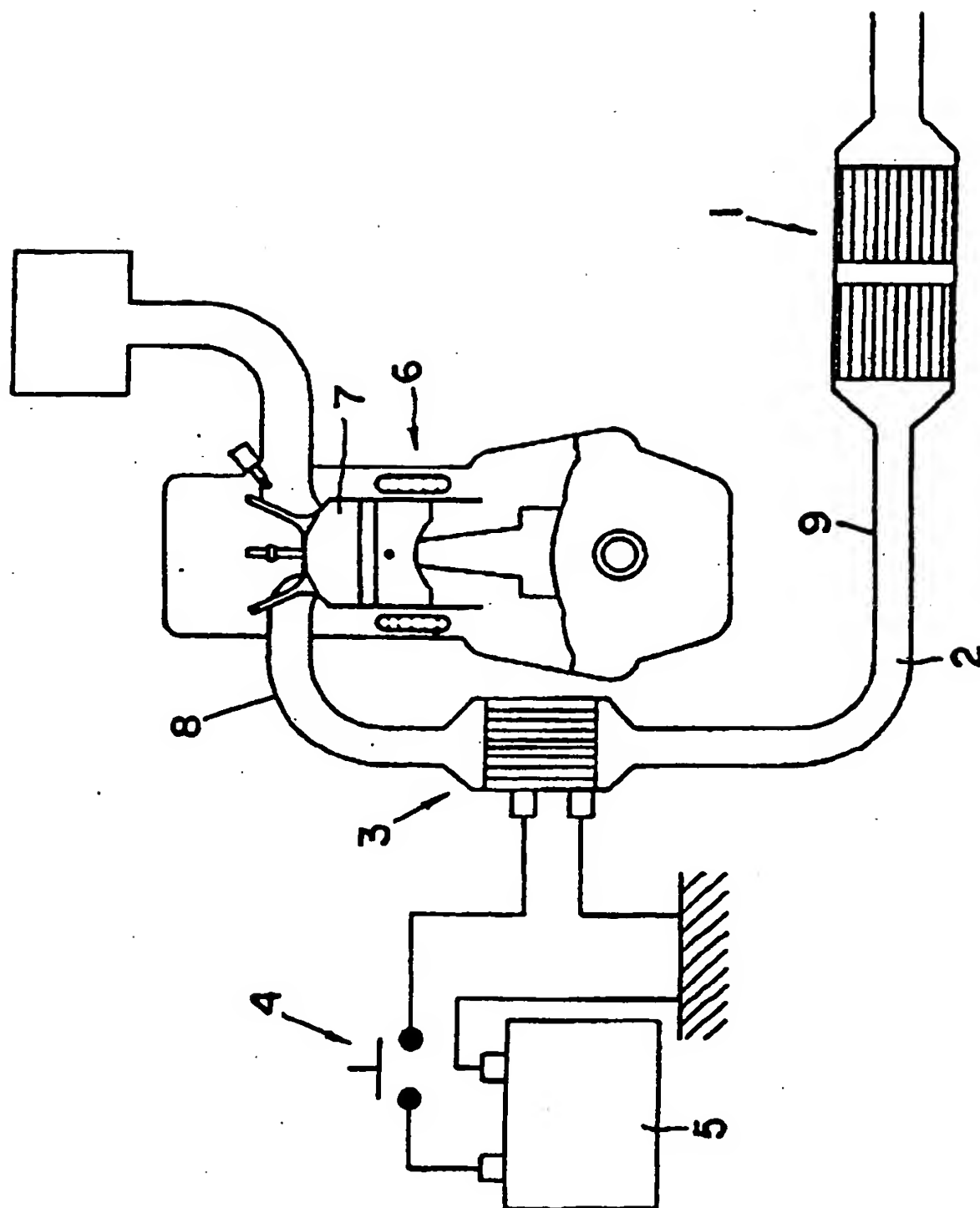


FIG.22





European Patent  
Office

## EUROPEAN SEARCH REPORT

Application Number

EP 93 10 3771

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X A	WO-A-8 910 470 (EMITEC)  * page 12, line 7 - page 14, line 18; figures 1-9, 11 *  -----	1, 2, 4, 5, 7, 8, 11 3, 6, 10	F01N3/28
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			F01N
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 15 JUNE 1993	Examiner HAKHVERDI M.
<b>CATEGORY OF CITED DOCUMENTS</b>  X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document  T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- & : member of the same patent family, corresponding document			

EPO FORM 1503 01.92 (P0401)